

TDP (Honours) 6th Semester Exam., 2023

PHYSICS

(Honours)

FOURTH PAPER : DSE – IV

Full Marks : 80

Time : 3 Hours

*Answer from **both** the Groups as directed.*

The figures in the margin indicate full marks.

*Candidates are required to give their answers
in their own words as far as practicable.*

GROUP—A

1. Answer any **eight of the following questions :**

2×8=16

- (a) What do you mean by nanostructured material?
- (b) Write the importance of defects in nanomaterials.
- (c) Draw the variation of Density of State (DOS) as a function of energy for 0-d and 2-D nanoparticles.
- (d) What do you mean by radiative and non-radiative transitions?

(2)

- (e) What is physical vapour deposition technique?
- (f) What is fluorescence?
- (g) Can excitons be considered as quasiparticles? Justify your answer.
- (h) What are nanowires? What unique properties do they possess at nanoscale?
- (i) What properties of nanoparticles make it useful in the development of high performance electronic display?
- (j) Define magnetoresistance.

GROUP—B

There are four questions from Question No. 2 to Question No. 5. Answer either (a) or (b) from each question given below : $16 \times 4 = 64$

2. (a) (i) How are the nanoscale systems different from bulk systems? Explain.
- (ii) How are the nanoscale systems used in medicine and healthcare?
- (iii) What are nanodots? What unique properties do they exhibit at the nanoscale?

PHSH-6/1234

[Continued]

(3)

- (iv) What is tunnelling conductivity? How does it occur in nanoscale system? What factor influence the tunnelling conductivity of nanoscale structure?
 $3+3+(2+2)+(2+2+2)=16$

(OR)

- (b) (i) Explain the phenomenon of coulomb blockade in nanoscale system.
- (ii) Explain the consequences of quantum confinement.
- (iii) How do nanowires differ from nanorods in terms of their structure and properties?
- (iv) What is hopping conductivity? How does it occur in nanoscale system? How does it differ from metallic conductivity?
 $3+3+(2+2)+(2+2+2)=16$

3. (a) (i) What is ball milling? How does it affect the structure, size and properties of nanoparticles? Write the advantages of using ball milling for nanomaterial synthesis compared to other methods.
- (ii) What is top-down and bottom-up approach in nanoscience? Write the differences between these two techniques.

PHSH-6/1234

[Turn Over]

(4)

- (iii) Explain the working theory of SEM technique. $(2+2+2)+(2+2+2)+4=16$

(OR)

- (b) (i) What are the key principles and processes involved in thermal evaporation, a type of physical vapour deposition technique? Write the advantages of this technique.
- (ii) How does the sol-gel process contribute to the synthesis of nanomaterials? What are the key factors that influence the stability and homogeneity of sol-gel derived nanomaterials?
- (iii) What information can we get from SEM image of nanomaterials? $(2+3+3)+(3+3)+2=16$
4. (a) (i) What are quasiparticles? How do they differ from elementary particles?
- (ii) How do excitons and quasiparticles contribute to the understanding of optical properties and energy transfer in materials?
- (iii) Write short notes on (a) surface plasmon resonance and (b) lithography. $(2+2)+(3+3)+(3+3)=16$

PHSH-6/1234

[Continued]

(5)

(OR)

- (b) (i) What do you mean by Morse potential energy curve? Explain graphically.
- (ii) State and prove Beer-Lambert's law. What are the limitations of it?
- (iii) What is Luminescence? Write the difference between electroluminescence and photoluminescence. $(2+2)+(1+3+2)+(2+4)=16$
5. (a) (i) Describe the working theory of a solar cell with schematic diagram.
- (ii) How do different nanomaterials (both organic and inorganic) impact the performance of solar cell in terms of its figure of merit?
- (iii) Explain the working of LEDs to achieve high efficiency light emission. Write two practical applications of LED. $5+5+(5+1)=16$

(OR)

- (b) (i) What is magnetic quantum well? How does it differ from a traditional quantum well structure? What are the unique properties and behaviours exhibited by electrons in a magnetic quantum well due to the presence of magnetic field?

PHSH-6/1234

[Turn Over]

(6)

(ii) Do a comparative analysis of quantum dots, nanowires and thin films with respect to the application in photonic devices.

(iii) What is optical switching?

$$(2+2+2+2)+6+2=16$$

